Organodynamics – The new science of getting useful work out of organisations

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Abstract

This paper argues that, fundamentally, a high-performing team in one that sustainably achieves outcomes characterised by the 'whole' being demonstrably and consistently greater than the sum of the appropriate 'parts'. This outcome 'surplus' is an emergent property that results from the team behaving as a well-connected self-organising system, in contrast to a 'heap'; a well-connected self-organising system that maintains a high degree of order – and hence low entropy - over time. Since natural systems have a tendency to degenerate into disorder and chaos, and for entropy to increase, maintaining order over time will not happen of its own accord. But it can be made to happen by pumping energy into and through the system. In organisational terms, this is the role of leadership, continuously pumping energy into the community of appropriately selected members, who collectively are well-connected, and who each individually exercise self-imposed constraints on their own behaviours, so that the actions and decisions they take are consistently in the interests of the team, rather than the individual. These principles are encapsulated as the 'Three Laws of Organodynamics' – the organisational equivalent of the scientific 'Three Laws of Thermodynamics'.

Key words

High-performing teams, thermodynamics, entropy, order, self-organisation

Introduction

The invention of the steam engine marked a major milestone in human history. Until that time, any work that needed to be done was powered by the muscles of humans or animals, or, where natural conditions permitted, by water or wind. But humans and animals get tired, and if the wind isn't blowing or the water flow slows down, the windmill and the watermill stop. The steam engine was truly transformational: steam engines don't get tired, and to make steam, all you need is some water and a fire. But as soon as the steam engine was invented, some challenging questions arose: How can we make these engines more efficient? Is there a maximum limit to the efficiency of an engine? For a given amount of heat used as the energy input, what is the amount of energy that can result in the form of useful work? So, over the decades in the middle of the nineteenth century, a roll call of the greatest scientists of the era - Max Planck, William Thomson (later Lord Kelvin), Rudolf Clausius, Sadi Carnot, Josiah Willard Gibbs, James Clerk Maxwell, Ludwig Boltzmann, to name just a few – answered these questions, and formulated the branch of science known as thermodynamics.

Thermodynamics is the science of how to get useful work out of engines; the purpose of this paper is to introduce *organodynamics*, the science of how to get useful work out of organisations. And, in accordance with Arthur Koestler's profound insight concerning creativity (Koestler, 1964, p. 120):

> ***The creative act is not an act of creation in the sense of the Old Testament. It does not create something out of nothing; it uncovers, selects, re-shuffles, combines, synthesises already existing facts, ideas, faculties, skills. The more familiar the parts, the more striking the new whole.***

let me cite, and duly acknowledge, the 'already existing facts and ideas' which this paper 'synthesises': firstly, the body of knowledge known as thermodynamics (see, for example, Zemansky, 1968; Sherwood, 1971; Adkins, 1983); secondly, the extensive literature on teamwork and leadership (see, for example, McKenna and Maister, 2002; Goffee and Jones, 2006; Schwaninger, 2006; Gratton, 2009); thirdly, the systems perspective in general (see, for example, Sterman, 2000; Sherwood, 2002; Morecroft, 2007), and the concepts of emergence and self-organisation in particular (see, for example, Lewin, 1993; Bak, 1997; Meadows 1997; Mulgan, 1997; Johnson, 2002); fourthly, the work of Peter Senge and his collaborators, with especial reference to the learning organisation, and the team as a self-organising system (Senge, 1990; Senge et al. 1994; Senge et al., 1999); and fifthly a number of more specialised sources (see, for example, Eriksson et al., 2006, Mazurkiewicz, 2008, and Bratianu and Orzea, 2013).

Koestler's definition of creativity highlights the importance of bringing together different strands of thought, which, once assembled, form a 'striking new whole'. Prior to that final act of synthesis, however, those strands are perceived as separate, independent, fragmented. So let me alert you to the likelihood that you might find the first few sections of this paper rather haphazard – but let me reassure you that the 'striking new whole' will indeed emerge when those apparently haphazard strands are brought together.

My starting point is therefore to examine, independently, these themes:

- how 'wholes' can, potentially, become greater than the sum of their 'parts'
- well-connected systems and emergence
- feedback and constraints
- selection, order and self-organisation
- why maintaining order over time is difficult, and
- entropy.

Then, once these different 'fragments' have been discussed, I can then weave these apparently disparate strands together to form the 'striking new whole' of *organodynamics* – the new science of how to get useful work out of organisations. And since there is a possibility that some readers of this paper might not be totally acquainted with the appropriate details of all of these contributory fields, I take the liberty of providing (I trust succinctly and accurately) the required background, each signposted with relevant headings – those already familiar these areas may of course skip the corresponding sections.

The central issue – making the 'whole' greater than the sum of its 'parts'

The question "what, precisely, is a high-performing team?" has been posed, and addressed, for eons, and will continue to be discussed and debated for years to come. For the purposes of this paper, I would like to deconstruct this question into two components, one focusing on outcomes, the other on processes:

"What is it that a high-performing team achieves, which is different – significantly so – from what the members of that team might achieve otherwise?" and

"What is it, specifically, about the organisation and structure of a high-performing team that enables it to achieve that different outcome?"

To explore these questions, let's assume that the team is composed of *n* individuals, each of whom can produce an outcome, over a given time, of, say, 1 unit of work, when operating at maximum personal efficiency. The *n* people, working by themselves over the same time, can therefore achieve a maximum outcome of *n* units of work. In practice, the outcome might be less than this – if a particular person is lazy, for example, or if another makes a mistake and has to do some rework. So *n* units of work is the maximum theoretical achievement.

Let's now consider those same *n* people, working over the same period of time, but together, rather than separately. What is the outcome? There are three possibilities, the first being *n* units of work, exactly the same as the outcome of the *n* people working efficiently by themselves. A second possibility is an outcome less than *n* units of work – a situation in which any member of the community is thinking "if you want something done, do it yourself!". Yes, we've all seen, and indeed worked in, dysfunctional 'teams' where everyone is in everyone else's way, where no one quite knows what they are doing, and where the whole is manifestly less than the sum of its parts. But we will also all have had the (perhaps rarer) experience of just the opposite – the buzz, the drive, the fulfilment of being a member of a team where the outcome is just wonderful, where the outcome of *n* people, working together as a high-performing team, is substantially *greater* than *n* units of work, where the whole is significantly greater than the sum of its parts.

Surely, the manifestation of the whole being greater than the sum of its parts is the hallmark of a truly high-performing team. That's what happens with the best sports teams; that's what happens in a musical ensemble, from a jazz quartet to a symphony orchestra. I particularly like the example of an orchestra as a high-performing team, for, in contrast to the win-lose nature of sport (and even the losers can be a great team), an orchestra is win-win – those in the audience experience great music, the players themselves are totally engaged, the composer has the joy of knowing that her creation has made the world a better place.

But wholes need not necessarily be greater than the sum of their parts, as vividly illustrated in the commercial world by the examples of asset-stripping and de-mergers, in which large conglomerates are broken apart to release value, and by the failure of so many mergers to result in the 'synergy' so hyped-up in the merger proposals. No, just putting people together, and calling them a 'team', rarely results in the whole-being-greater-than-the-sum-of-its-parts – or, as stated rather more vividly by Gary Hamel in a lecture I attended many years ago, "two turkeys don't make an eagle".

My answer to my first rhetorical question, "what is it that a high-performing team achieves?", is therefore "a high-performing team achieves far more than the individuals would achieve, if working by themselves", which is all about wholes being greater than the sum of the corresponding parts.

So let me now turn to the second question "What is it that enables this to happen?"…

Well-connected systems and emergence

As we have just seen, the key characteristic of a high-performing team is the team's demonstration, day after day after day, that it's whole is sustainably greater than the sum of its parts: the outcome of the *n* people working together is manifestly and continuously greater than *n* units of work. But this in turn poses a puzzle: where does the 'extra' outcome, the 'surplus', come from? What is its origin? And how is it created? To which the short answer is 'emergence' (see, for example, Sherwood, 2002, p.14 and Johnson, 2002) – which, if unfamiliar, I explain here.

Let me do this by performing a magic trick: "I went to the bank".

Magic? What's magic about that? It's only a sentence, and a very simple sentence at that!

Yes, it is a simple sentence, but it also contains some magic too. The magic of *meaning* – those people who know the English language know the meaning of "I went to the bank".

But where – precisely - does that meaning reside? An easier question to answer is where the meaning *doesn't* reside: it doesn't, for example, reside within the word 'bank', or within the word 'went' – indeed, the most eminent professor of language could spend a lifetime studying the word 'bank', yet never discover the meaning of "I went to the bank". No, the meaning does not reside within any single word; the meaning resides at the level of the *sentence as a whole*. But that sentence-as-a-whole is itself interesting, and merits some (perhaps unexpected) attention. Yes, the sentence is comprised of words in the English language. But not just any-old words, thrown together randomly; rather, the sentence is comprised of some very specific words, strung together in a very specific sequence, and deliberately chosen and structured to convey the meaning I intend.

So, as a counter-example, consider "to I bank the went". This comprises exactly the same words, but in a different order, and is meaningless (unless I work very hard to untangle the meaning, which I might do with just five words, but is impossible with a longer sentence, let alone a book). "I went to the" has the promise of meaning, but doesn't quite get there since a vital word is missing; and "I went to the bank shoulders" has an unexpected extra word, which presents a puzzle rather than meaning. And "I manufactured to the bank" doesn't make much sense either, even though 'manufactured', as a verb in the past tense, in that position in the sentence, fully complies with the laws of English syntax and grammar.

"I went to the bank" is not an accidental assembly of randomly chosen words: on the contrary, it is a very carefully constructed *well-connected system* – a system which has just the right component parts, connected together in just the right way. And as a result, the system shows *emergence*, the existence of a property at the level of the system as a whole, a property which is not attributable to any single component within the system, a property which in this particular case is manifest as meaning.

Importantly, not all systems – where the definition of 'system' used here is 'a community of connected entities' (see, for example, Sherwood, 2002, p.12) – show emergence. So, for example, "to I bank the went", complies with this definition of 'system' by virtue of the fact that the words are strung together in a particular order, but there is no emergence. "I went to the bank", however, also complies with this definition of a system, but does show emergence because it is a *well-connected* system, specifically designed to convey the required meaning, and successful in doing so.

Emergence is therefore a property of well-connected systems, and is evident in many fields. All music, for example, is formed from patterns of different audible tones – the notes on a piano, for example – but any-old jumble of tones is a cacophony, not music: great music is the emergent result of a very carefully assembled well-connected system of tones, tones that, collectively, create the emergent property of touching our emotions; likewise, great art is a very carefully crafted pattern of colour, a well-connected system that shows the emergent property of, for example, aesthetic beauty. And another example of a well-connected system is you, and me too: all our 'bits' are put together in a very special way, which shows any number of emergent properties from consciousness to emotions such as love, as well as physiological characteristics such as our body temperature of around 37ºC. And if we have a 'bit' missing, or a 'bit' too much, or if our 'bits' are 'rearranged', then our system breaks down, perhaps with fatal consequences.

Feedback and constraints

As we have seen, "I went to the bank" Is an example of a well-connected system, with the emergent property of meaning. But what happened next? Did I deposit some money in my account? Did I authorise a payment? No. Neither of these. "I went to the bank, sat down, and watched the magnificent swans glide past." Ah! It isn't 'that' sort of a bank, the financial institution sort – it's the bank of a river.

This illustrates a further feature of well-connected systems: the way in which events elsewhere in the system influence other parts of the system - in this case, reference to 'sitting down' and 'watching the swans' provides information which influences how we interpret the word 'bank'. In the sentence "I went to the bank", the word 'bank' can be understood in several different ways: for example, the financial institution, the side of a river, or even a blood bank - which I might go to as a blood donor, or, if I were a medical doctor, for blood for a transfusion. Certainly, most people assume the financial institution, but that's an assumption by the observer, not a property of the system itself. It's not until there is some further information, information that provides *feedback*, that the ambiguity is resolved.

And in doing so, something is happening at a rather deeper level: the feedback is constraining 'degrees of freedom'. In the case of the sentence, the word 'bank' can be thought of as having three 'degrees of freedom' – the financial institution, the side of the river, the repository for blood. The action of the feedback is to eliminate two of those, and 'constrain' the meaning of the word 'bank' to 'the side of a river'.

Feedback and constraints are also fundamental to the behaviour of high-performing teams. Take, as an example, a star soccer player, say, David Beckham. At any instant in the game, he has any number of choices - let's imagine he has the ball at his feet – he could take a shot, he could dribble the ball into free space, he could deliberately approach an opposing defender to get closer to the goal, he could pass… How does he decide which choice to make? In fact, two activities are taking place simultaneously. Firstly, there is a huge amount of feedback: Beckham is continuously processing information fed back to him from the positions and activities of every other player on the pitch – where they are, what directions they are facing, how fast they are moving. And secondly, he is taking a decision, a decision which constrains his choices, which limits his 'degrees of freedom'. Does he go for personal glory, or does he take the action which is in the best interests of his team? To a good team player, the answer is self-evident: instead of trying to be a hero, and attempting to jiggle past three defenders to score the wonder goal, he passes to a team-mate who is well positioned to hit the back of the net. It's all about feedback and constraints. To ram home the point: if Beckham were wearing earmuffs and a blindfold, so breaking the channels for feedback, he wouldn't be so effective; furthermore, if his choices were only about 'me, me, me', he wouldn't last long as a member of a high-performing team.

And it isn't just about sport: exactly the same applies to the orchestra, in which the trumpet player is totally alert to all the surrounding instruments, and, voluntarily and spontaneously, chooses to play softly so as to allow the flute to be heard. Members of high-performing teams are always giving and receiving feedback, and voluntarily choosing to constrain their instantaneous behaviours, choices and decisions to those that are to the benefit of the team, rather than themselves.

Selection, order and self-organisation

I've referred to a 'well-connected' system several times, so my next task is to dig more deeply into precisely what 'well-connected' means. A well-connected system has two important attributes – selection and order.

Firstly, selection. In a well-connected system, each of the component parts from which the system is formed is specially selected, and fully fit-for-purpose. That's the difference between "I went to the bank" and "I manufactured to the bank"; that's why a jazz band has a sax player and a drummer. This does not imply that the sax player can't play the drums; rather, it means that, at the current time, it's in the best interests of the team for the sax player to play the sax and the drummer the drums. And importantly, the sax player must be able to play the instrument to an appropriate level of proficiency – he's not a member of the band just because he's a nice guy. So you're asking for trouble if a 'team' is thrown together in an organisation simply because a bunch of people happen to be working under the same roof.

The importance of selecting the 'right' team members is obvious, even if, for all sorts of reasons, often not adhered to in practice; the second attribute, order, isn't quite so obvious, and is even more important…

The difference between "I went to the bank" and "to I bank the went" is obviously one of sequence: the words in each of these 'sentences' are the same, but in a different sequence, with one sequence having the emergent property of meaning, and the other not. The specific, meaningful, sequence of words in this sentence is a particular case of a broader concept, that of 'order' – 'order' in the sense of 'well-ordered', as contrasted with 'random'.

Which takes us back to high-performing teams: a fundamental, but rather subtle, feature of a high-performing team is *the maintenance of a high degree of order, over time*. To make that more vivid, imagine you are in a helicopter, observing the movement of people in a busy city square. You carefully follow the movement of a single person, and watch that person head from one side of the square to the other, more or less in a straight line. Then you see another person, who might stroll in a more leisurely fashion to a bench at the centre of the square, sit down for a while and then wander on. Sometimes, two people, perhaps a couple, will walk together. But suppose you choose two people at random, and then measure the *correlation between their movements*: the likelihood is that the correlation will be close to zero – people moving across the square are 'doing their own thing'.

Now you pilot the helicopter to hover over the local soccer field, where two teams are playing. This time, when you correlate the movements of any two random players on the field (and the referee and touch judges too, as well as the eye movements of people in the crowd), you will measure a very high degree of correlation as the players, on both sides, position themselves according to the instantaneous locations of the ball and the other players, and the overall state of the game - as has indeed been verified in the simulated environment of 'robot soccer' (Balch, 1997; Balch, 2000), and on the real basketball court (Fewell et al., 2013; Shea and Baker, 2013). Likewise, in an orchestra, the violins and the flutes are not just 'doing their own thing', they are (quite literally) 'on the same page', playing their instruments harmoniously, and (again quite literally) in concert.

The actions of the soccer players, and of the members of an orchestra, are not accidents: they are very deliberate, and examples of a fundamental feature of all high-performing teams: *high-performing teams demonstrate a high degree of order, and maintain that order sustainably over time*. That's important, and serves as bridge to another term used to describe well-connected systems which maintain a highly-ordered state over time – self-organisation.

"I went to the bank" is a trivial example of a well-connected system, but this system is static – it doesn't change over time. Another, more vivid, example of a well-connected system that is neither trivial nor static is a hurricane. In this case, the entities that comprise the system are molecules of water, and the constituents of the atmosphere; the emergent properties that this system displays are its huge physical structure, and its enormous destructive power.

These emergent properties of the hurricane as a whole cannot be inferred from any study, however exhaustive, of an individual water molecule; furthermore, these emergent properties are maintained for a considerable time, even as the hurricane moves. And as it moves, it does not retain exactly the same shape, for it 'bends' and 'weaves'; what is maintained is the generic structure of a vigorously rotating vortex. It is almost as if the hurricane is a living being – but it isn't. Rather, it's a manifestation of a special type of emergence, known as *'self-organisation'* – the ability of a complex, dynamic system to preserve an overall, ordered, cohesive structure – and even purpose – over time.

Another example of self-organisation is the behaviour of a flock of birds; another is the pattern of stripes on a tiger; another is the regular rhythm of our heart-beat.

And another is the performance of a high-performing team: so here's the punch-line - ***teamwork is the emergent property of a community of people which becomes evident when that community begins to behave as a well-connected self-organising system, rather than as a 'heap'; a well-connected self-organising system that maintains a high degree of order over time.***

Only when the heap becomes a well-connected self-organising system does the whole begin to become greater than the sum of its parts. So, if we wish, deliberately, to *make* the whole become greater than the sum of its parts, and to maintain the correspondingly high level of performance over time, then the only way in which we can do this is by *building a well-connected self-organising system, maintaining its order over time, and stopping it from disintegrating into a 'heap'*.

Why maintaining order over time is difficult

As we have seen, one of the central features of a high-performing team is the maintenance of order over time. It turns out that, in a very real sense, this is an unnatural act. For, as a general rule, things naturally descend into chaos and disorder.

Why so? Because that's what the Second Law of Thermodynamics tells us. Let me explain…

The Second Law of Thermodynamics is notorious as one of the most difficult of the laws of physics to understand. That's because the textbooks often state it in language such as *"It is impossible to construct a device which operates in a cycle and has no effect other than performance of useful work and the exchange of heat with a single reservoir"*. That does take a while to get your head around, so let's park this one for a moment (despite it's being attributable to the great nineteenth century physicists Lord Kelvin and Max Planck), and focus on another way of expressing the law: *Systems spontaneously degrade from an ordered to a disordered state*.

In essence, this statement encapsulates our experience that many real-life processes act spontaneously in one direction only. You can put milk into black coffee and the two fluids will spontaneously mix, but even if you wait from now until doomsday, the coffee will never separate itself from the milk; an ice-cube will spontaneously melt in your whisky, but whisky-and-water will never form neat whisky and an ice-cube of its own accord; your teenage son's tidy room becomes a tip within five minutes, a natural phenomenon which never, just never, works in the other direction.

These unidirectional events are part of our every-day experience, and are closely associated with our perception that time flows only forwards and not backwards. And central to our understanding of time – but often not explicitly recognised as such - is our experience of 'order' and 'disorder'. If, for example, we see a film of a tall chimney being demolished and falling to the ground in fragments, this transition from a highly ordered state (a neat vertical stack of bricks) to a highly disordered state (a million bricks strewn randomly on the ground) causes us to infer that time is moving in the right direction; if, however, we see the random mess of bricks suddenly organise themselves into a tall chimney, we infer that the film is running backwards.

The Second Law of Thermodynamics tells us that the natural state of things is for order to be transformed into chaos; that this transition from order into chaos will happen spontaneously, of its own accord. This is true. But it does not deny the existence, the maintenance or indeed the creation of ordered states. Rather, it tells us that if we wish to create order out of chaos, or to prevent something ordered from degenerating into chaos, then we have to do something very deliberately and actively: ***we have to expend energy to create the ordered state in the first place, and to continue to expend energy to maintain it***. As indeed every parent knows all too well as they tidy that teenage son's room. That also explains why we breathe: we take in oxygen from the air, which is carried in our blood to each of our cells, in which the oxygen is used to burn sugars to create energy, the energy that holds us together. The sugars are also taken in from the outside world, in our food, and are themselves ultimately derived from plants which make sugar molecules from water and carbon dioxide, using the sun's energy, in the process known as photosynthesis. This energy flow, originating with the sun, maintains the order within our bodies, and keeps us alive – if we stop breathing, the energy flow ceases, our internal order degenerates into chaos, and we die.

Entropy

A further result of the science of thermodynamics was the discovery of a *measure of order* – or rather disorder: scientists talk of *entropy*, with high levels of entropy being indicative of a relatively high degree of disorder and chaos, and low levels of entropy signifying a relatively low degree of disorder and chaos. Entropy and order go in opposite directions – high entropy, the 'natural' state, implies low order; low entropy, the 'unnatural' state, implies high order. And entropy can be incorporated into an alternative statement of the Second Law: the entropy of the universe increases. Indeed it does.

Back to teams. High-performing teams sustain a low entropy (highly ordered) state over long periods of time. That's the only way they can behave as well-connected systems which display the emergent property of the whole-being-greater-than-the-sum-of-its-parts. And the only way a low entropy state can be maintained is by a continuous flow of energy. Mmm…

Bringing it all together

The story-so-far has been wide-ranging and fragmentary. Systems theory. Emergence. Soccer teams. Life. Order. Chaos. Entropy. Thermodynamics. A bit all over the place… So let me now bring the fragments together…

If we wish to realise the value of enhanced teamwork, then we have to ***make*** the whole greater than the sum of the parts. This will not happen spontaneously, of its own accord, by itself. It is a deliberate act: to make the whole greater than the sum of the parts requires us to create a well-connected, highly-ordered self-organising system from the appropriate component entities; a self-organising system that can exhibit the emergent property of enhanced performance; a self-organising system which maintains a high degree of order over time. And the ***only way*** this can be done is by creating the conditions in which:-

- there is a powerful **flow of energy** through the team
- the members of the team are appropriately **selected** and **connected**
- the members of the team exercise, voluntarily and intuitively, appropriate **constraints**.

All three conditions must apply simultaneously, and be maintained consistent over time.

In the absence of the energy flow, the whole structure will fall apart, as the system disintegrates into a heap. That's what happens in living organisms, for, as we have already seen, when the energy flow stops (we stop breathing), we quite literally fall apart (we die and decompose). And that's what happens in organisations too.

If the entities are not appropriately connected – for example, if the communications are poor, if the policies, procedures and processes are not aligned, if the performance measures drive divergent behaviours, if there is no trust – the system ***cannot*** behave as a well-connected highly-ordered system. It must degrade into a heap.

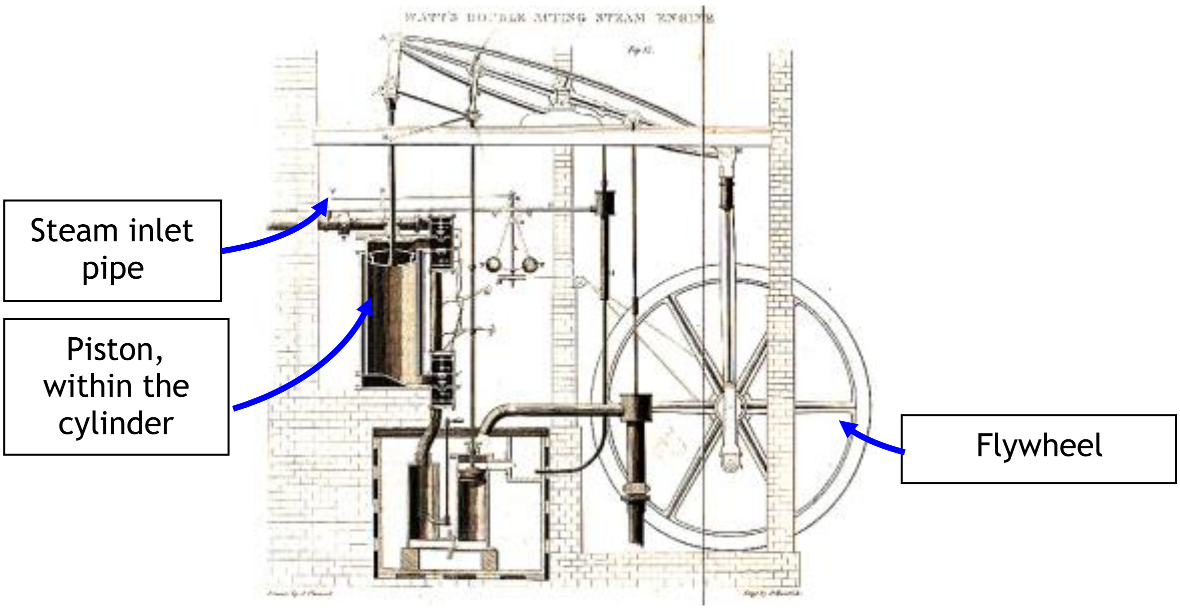
And even if the entities experience strong energy flow, and are well-connected, but do not voluntarily constrain their behaviours – for example, if sales people compete destructively with each other, if there is an attitude of 'not invented here', if people behave parochially or myopically - then forget it. No way can the whole ever become greater than the warring parts. No way can that alluring prize of the whole-being-sustainably-greater-than-the-sum-of-its-parts ever be won.

Introducing the new science of *organodynamics*

Three fundamental concepts – **energy flow**, **selection and connectedness**, and **constraints** get you thinking: thinking about the possibility of three ‘laws’ which encapsulate how these concepts apply to real organisations. Triplets of laws, in fact, have some currency in physics – Kepler’s Three Laws of the Planets, Newton’s Three Laws of Motion, and the Three Gas Laws (Boyle’s, Charles’s and Gay-Lussac’s), to name three sets of three. But the triplet that is of particular relevance here is associated with arguably the greatest intellectual achievement of the nineteenth century physical sciences – the science of thermodynamics.

As I’ve already mentioned, thermodynamics is all about how to extract work from systems, in particular, the type of system we call an ‘engine’. Most of the development of thermodynamics took place before the invention of petrol or diesel driven internal combustion engines, so the kinds of engine that were studied at that time were steam engines – steam engines rather like the one shown in the diagram:

James Watt’s “Double Acting” Steam Engine, 1782



This is a line drawing of one of James Watt’s steam engines, the purpose of which is to make the large *flywheel* rotate. Steam from a boiler (not shown, but to the left of this diagram) passes through the *steam inlet pipe* and enters the *cylinder*, so driving the *piston*. The way in which the steam is introduced into the *cylinder* powers the *piston* in both directions, hence the term “double-acting”. The up-and-down motion of the piston rocks the horizontal beam (at the top of the diagram), so causing the *flywheel* to rotate.

Steam engines are of course ‘systems’, for they constitute a ‘community of connected entities’: the boiler is connected in a specific way to the cylinder and pistons, and the piston is connected to the ‘working end’ of the engine, say, a water pump (for keeping mines dry), or to a flywheel which can drive a weaving machine (so powering the industrial revolution), or a set of wheels (so forming a ‘locomotive’). If these ‘entities’ are not connected together, or connected in a rather different way, the engine just won’t work. So an engine is indeed a system, with carefully selected, and well-connected, component parts. And as a well-connected system, it can show emergent properties – in this case, the ability to keep a mine dry, to drive a weaving machine, to power a locomotive, to do useful work.

The power source for a steam engine is of course the steam, created by boiling water using the heat produced from burning coal or wood. Overall, what the engine does is to release (originally the sun’s) energy trapped in the coal or wood as heat, and then transform that heat into useful work: all the paraphernalia of the boiler, the cylinder and the pistons are simply the means by which this all happens. But they are necessary features of the system, for if heat is simply applied to water, the water gets hotter until it all boils away – no useful work is done at all. It’s only when the steam is linked to the rest of the carefully designed system that useful work can indeed be done.

Can organisations, can teams, be considered as well-crafted ‘engines’? Engines in which various inputs are combined together by a well-designed, well-connected system to create useful work? And if, so, is there a parallel between the laws of thermodynamics, and a new science of *organodynamics*? If you are familiar with the Three Laws of Thermodynamics, please skip the next section and go straight to my discussion of the Three Laws of Organodynamics; but for those of you that might appreciate a quick refresher, let’s take a closer look at all the three laws of thermodynamics...

The Three Laws of Thermodynamics

The First Law

Energy can be neither created nor destroyed.

This is a statement of conservation of energy. It states that ‘energy’ can manifest itself in many different ways – such as what we call ‘heat’ and ‘work’ - but the total energy (of the universe, in fact) is constant. So, in a steam engine, the amount of energy released by the burning of the fuel gets transformed into, for example, the work the engine actually does, as well as sound energy (the clanking of the engine), and also ‘losses’ due to, for example, friction. All the energy, however, is accounted for – no energy ‘disappears’, and no energy ‘comes from out of the blue’: the energy books always balance.

The Second Law

I've already introduced the second law as stated as

Systems spontaneously degrade from an ordered to a disordered state.

So, let's go straight to…

The Third Law

It is impossible to reach the absolute zero of temperature in a finite number of steps.

Measurement is integral to many aspects of the physical sciences, and all measurements are made according to appropriate scales. The zero value of many measurement scales is arbitrary, and agreed by some sort of convention: measurements of position on the earth, for example, are made by reference to the zero of the Greenwich meridian for east-west measurements, and the zero of the equator for north-south measurements. It turns out that temperature is rather special: although the zero of the centigrade scale is set (arbitrarily but conveniently) as the freezing point of pure water, there is a temperature below which you just cannot go. This is known as 'absolute zero', and corresponds to about 273ºC below the freezing point of water. In physical terms, temperature is a manifestation of molecular motion, and the absolute zero of temperature corresponds to the point at which all molecular motion ceases. The Third Law states that although the absolute zero of temperature exists, in practice, we can't reach it. We can get close, but never there.

Well, that's enough of that!! Let's get back to teamwork and organisations...

The Three Laws of Organodynamics

The First Law

Organisational energy must continuously be created lest the organisation itself be destroyed. That's what leadership is all about.

In contrast to the First Law of Thermodynamics, which states that physical energy can neither be created nor destroyed, the First Law of Organodynamics states quite the opposite: that organisational energy must continuously be created. For if it isn't, the organisation will degrade and fall apart. From a systems point of view, this recognises that a team is a system through which energy must flow to maintain order. But from an organisational point of view, this throws the spotlight on how fundamentally important it is for energy to be injected into, and continuously to flow through, the team.

As indeed is quite obvious in sport, where the teams on the pitch have energy pumped into them by the cheering crowd – imagine how leaden a game might be if the two teams just ran around in an empty stadium. The crowd, of course, is not the only source of energy for the team – there's the team manager too: and you will know from your own experience that the most compelling attribute of a great leader is that person's ability to make you feel good, to motivate you, to lift you when you feel down, to keep you going when times are tough – and we even refer to great leaders using words such as 'energising', 'exciting', 'dynamic', 'stimulating', 'invigorating', all of which are about the way in which the leader injects energy into us.

This constant pumping of energy into other people places a huge demand on leaders, and explains why leadership is so tiring. And it also raises the question of who pumps energy into the leader. Louis XIV of France might not be amongst the conventional pantheon of great organisation designers, but he must surely have understood the importance of maintaining order by pumping energy into the system – he was, after all, referred to as "The Sun King", and during his reign, France was indeed a relatively well-ordered state; furthermore, it wasn't that long after he died that things in France really did fall apart…

The Second Law

Organisations will spontaneously degenerate into chaos, and can only be prevented from so doing by ensuring effective connectedness between all the constituent parts of the organisation, with each constituent part voluntarily constraining their behaviour in accordance with the interests of the team.

The Second Law of Organodynamics mirrors that of Thermodynamics. In particular, it stresses that, in addition to the energy flow required by the First Law, the maintenance of order – and hence the team's ability to perform useful work - depends critically on the effective connectedness between the constituent parts of the team, and the constraints on individual behaviour. Just as an engine won't work if its constituent parts are connected any-old-how, so a team won't work if its component parts are not well, and effectively, connected together, and all behaving in a concerted way.

There is also an alternative statement of the Second Law of Organodynamics, just as there is of the Second Law of Thermodynamics. If in thermodynamics "It is impossible to construct a device which operates in a cycle and has no effect other than performance of useful work and the exchange of heat with a single reservoir"; then, in organodynamics, we can state "Not only is it quite possible, it is absolutely inevitable, that an organisation will continue to go round in circles, generating increasing amounts of heat, and progressively less useful work, unless the organisation works very hard indeed to do otherwise".

The Third Law

Although scientists can't reach the absolute zero of temperature, organisations sure can hit rock bottom: ultimately, organisations end up with the cultures they deserve.

If the Third Law of Thermodynamics states that the absolute zero of temperature can never be attained, the Third Law of Organodynamics states that the rock bottom of organisational behaviour is all-too-easy to reach.

What happens when someone new joins an organisation? Very quickly, they sense which behaviours are acceptable, and which are not. For the most part, this causes little tension, but there may be one or two areas where the accepted behaviour within the organisation is in conflict with what the individual feels is the right thing to do. What happens then? I suggest one of three things:

- the individual can agree to conform, and willingly change his or her personal preferences in order to conform, or
- the individual can become sullen and un-co-operative, or, worse, a 'terrorist', pretending to conform, but doing his or her best to 'commit sabotage' whenever the opportunity arises, until such time as the individual's behaviour is resented by the organisation, at which point, the individual is expelled, or
- the individual chooses, voluntarily, to leave.

The second and third options have the same result: the dissenting, non-conforming individual leaves the organisation. And the first option results in the individual conforming. Over a period of time, organisations therefore end up with the cultures they deserve, for only those people who tolerate that culture will survive or choose to remain. Everyone else is either fired or resigns. So the culture perpetuates...

Unless, that is, a leader deliberately decides to do something about it. How? By injecting energy. By ensuring appropriate selection and connectedness. And by redesigning the constraints.

Let's get real

So, let's come down from the dizzy intellectual ivory tower of systems theory, nineteenth century science, and the new science of organodynamics. It's time to get real.

Delivering the promise of enhanced teamwork is in essence about creating the 'Manchester United' (or the sports team, or indeed orchestra, of your choice!) of your sector, out of your existing 'players'.

There are all sorts of approaches to building high-performing teams, and there is a school of thought that it's all about having an abseiling event in the mountains, and managing to learn – and remember - the first names of our colleagues' partners. Yes, these help. But there is more to it than that. And the purpose of this paper is to suggest that a very powerful, pragmatic and hard-edged way of doing precisely this is to use the Three Laws of Organodynamics to define a series of real, meaningful and insightful questions that probe the three key issues of energy, selection and connectedness, and constraints, which apply not only locally within specific teams, but also to the overarching team represented by the enterprise as a whole:

- ***Organisational energy must continuously be created lest the organisation itself be destroyed. That's what leadership is all about.***
    - What are the energy flows through the business?
    - What are the sources of that energy?
    - How is that energy maintained?
    - Do all levels of leadership have a shared vision?
    - Do they articulate it consistently to their teams?
    - As a leader, what, specifically, do you do to pump energy into your team?
    - How do you know that what you are doing is having the desired effect?
    - How do you replenish your own sources of energy? And what do you do when you yourself are flagging?
    - How do you ensure that the energy flow is transmitted right through the team, without dilution or distortion?
    - What are you doing to encourage others to become their own sources of energy, so that they are progressively less reliant on you?
    - As a team player, how do you demonstrate to the leader that you appreciate the energy source?

- ***Organisations will spontaneously degenerate into chaos, and can only be prevented from so doing by ensuring effective connectedness between all the constituent parts of the organisation, with each constituent part voluntarily constraining their behaviour in accordance with the interests of the team.***
    - As a leader, what criteria do you use to select your team members?
    - What, specifically, do you do to ensure that team members are well-connected?
    - How do you ensure all your team members understand the importance of constraining their behaviours, and of taking decisions which are in the interests of the team rather than themselves?

- What specific, concrete examples are there of situations in which choices or decisions have been made in which the key players have constrained their behaviours to optimise the whole at the expense of their part? And indeed to optimise their part at the expense of the whole? What can we learn from this?
- Within your team, what the ‘rights’ of team membership? And the ‘obligations’? How explicit are they? And how well-known across the whole team?
- When someone new joins the team, how do they find out about these ‘rights’ and ‘obligations’?
- What happens when someone oversteps their ‘rights’? Or consistently fails to honour their ‘obligations’?
- When you have been a team member, can you think of situations in which you did not constrain your behaviours in the interests of the team? Why not? What insight does that give you as to how, as a leader, you can encourage others to do the ‘right’ things?
- Do the objectives, targets and performance measures applied to the different parts of the enterprise encourage collective, or individual, behaviours?
- What are the contexts in which the different parts of the enterprise interact? Are these interactions harmonious and productive? Or adversarial and dysfunctional? Are our goals, objectives, policies, procedures and processes naturally aligned, or are they all-over-the-place, implying that much time and energy is wasted on doing things more than once?
- What is the nature of the communication between the different parts of the organisation?
- How well do people in different parts of the organisation know one another, especially people in positions of authority and responsibility?
- And, fundamentally, how strong is mutual trust?

- ***Organisations end up with the cultures they deserve.***

  - To what extent, if any, do different parts of the organisation compete for the same resources (markets, customers, products, people, investments...)?
  - What is the nature of that competition? Is this competition co-operative (we both recognise the resource is finite, so we voluntarily agree to share the resource so as to optimise the outcome for the business as a whole) or adversarial (I’ll grab whatever I can, regardless of my need, and even more regardless of yours)?
  - To what extent do performance measures encourage, or discourage, behaviours which optimise the whole rather than my part?

- To what extent does the reward mechanism explicitly recognise and encourage decisions which optimise the whole, especially when they sub-optimise my part? When a new manager takes over, does that manager take over the 'in-tray' as 'work-in-progress', accepting his or her predecessor's decisions, or does the new manager say "we need to review this"?
- What specific, concrete examples are there of dysfunctions and disconnects? What can we learn from this?
- Most people are usually members of at least two different teams simultaneously – if only 'this team' and 'my family'. Sometimes, the demands of these different teams are in conflict, creating a situation in which honouring the commitments to one team inevitably implies that the other team is let down. How do you, and your teams, acknowledge, manage, and resolve this problem?

Conclusion

Thank you for reading this far! And I can well understand that you might be thinking "mmm…quite interesting….but nothing new…". That's true, in a sense. At one level there is nothing new – concepts such as self-organisation, entropy, emergence, and thermodynamics have all been discussed, thought about, studied, and put to practical use for years. Those indeed are the 'already existing facts, ideas' to which Arthur Koestler refers in his definition of creativity quoted at the start of this paper. But at another level, perhaps bringing these 'already existing facts, ideas' together into a single, well-connected system does achieve something of value: the emergent properties of deeper understanding, of more profound insight, of enriched awareness – a deeper understanding of a team as a well-connected system that maintains low entropy over time; the insight that this is an 'unnatural act'; the enriched awareness of the importance of energy flow, of selection and connectedness, and of self-imposed constraints. And with this deeper understanding, more profound insight and enriched awareness, perhaps you will be able to become not only a better builder and leader of teams, but also a better player in teams led by others too.

Footnote – the Zeroth Law

Aficionados of thermodynamics might have come across the so-called 'zeroth' law which states "If two bodies are in thermal equilibrium with a third, then all three bodies are at the same temperature". This is in essence a definition of temperature. Its analogue in organodynamics might be "If two organisations are in commercial equilibrium with a third, than all three organisations are commercially dead": stasis in the commercial world is a step on the road to commercial extinction – change, evolution and dynamism are essential for organisational survival.

References

Adkins CJ. 1983 (3rd edition). *Equilibrium Thermodynamics.* Cambridge University Press, Cambridge.

Bak P. 1997. *How Nature Works*. Oxford University Press. Oxford.

Balch T. 1997. *Social Entropy: a New Metric for Learning Multi-robot Teams, Proc. 10th International FLAIRS Conference (FLAIRS-97)*.

Balch T. 2000. *Hierarchic Social Entropy: An information theoretic measure of robot group diversity. Autonomous Robots **8** (3): 209 - 237*

Bratianu C and Orzea I. 2013. *The entropic intellectual capital model. Knowledge Management Research & Practice **11**: 133–141.*

Eriksson OM, Rae G and Smolyaninova J. 2006. *Meeting the Challenge of Social Sustainability: governance for profound change*, Master's thesis submitted to the Blekinge Institute of Technology, Karlskrona, Sweden, and https://www.bth.se/fou/cuppsats.nsf/all/d4c4eb25cbe46a33c125722500086084/$file/MGJ_Governance_for_Sustainability.pdf

Fewell JH, Ambruster D, Ingraham J, Petersen and Waters JS. 2012. *Basketball Teams as Strategic Networks, PLoS One **7**(11); e47445* and http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0047445.

Goffee R and Jones G. 2006. *Why Should Anyone be Led by You?* Harvard Business School Press, Boston.

Gratton L. 2009. *Glow: How you can radiate energy, innovation and success*. Financial Times/Prentice Hall, London.

Johnson S. 2002. *Emergence*. Penguin. London.

Koestler A. 1964. *The Act of Creation*. Hutchinson & Co., London.

Lewin R. 1993. *Complexity*. JM Dent, London

Mazurkiewicz A. 2008. *Social energy - A new form of perceiving capital in postmodern economy*, International Network for Economic Research, http://www.infer-research.net/files_publications/wp2008.4.pdf

McKenna PJ and Maister DH. 2002. *First Among Equals*. The Free Press, New York.

Meadows D. 1997. *Places to intervene in a system*. *Whole Earth*, Winter, http://center.sustainability.duke.edu/sites/default/files/documents/system_intervention.pdf and http://www.donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

Morecroft J. 2007. *Strategic Modelling and Business Dynamics.* John Wiley & Sons Ltd. Chichester.

Mulgan G. 1997. *Connexity*. Chatto & Windus, London.

Schwaninger M. 2006. *Intelligent Organisations*. Springer, Berlin.

Sherwood D. 1971. *Introductory Chemical Thermodynamics*. Longman Group Limited, London.

Sherwood D. 2002. *Seeing the Forest for the Trees – A manager's guide to applying systems thinking*. Nicholas Brealey Publishing, London.

Senge P, Roberts C, Ross R, Smith B and Kleiner A. 1994. *The Fifth Discipline Fieldbook*. Currency Doubleday, New York.

Senge P, Kleiner A, Roberts C, Ross R, Roth G and Smith B. 1999. *The Dance of Change*. Currency Doubleday, New York.

Shea SM and Baker CE. 2013. *Basketball Analytics: Objective and Efficient Strategies for Understanding How Teams Win*. Createspace

Zemansky M. 1968. *Heat and Thermodynamics*. McGraw-Hill Book Company, New York.